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Tuberculosis in the veterans healthcare system: a six-year review and evaluation of programme effectiveness

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SUMMARY

The Department of Veterans Affairs operates a large, centrally administered health care system consisting of 173 hospitals and 4 free standing outpatient clinics nationwide with approximately 945115 hospital discharges, 24·2 million outpatient visits, and 2·86 million persons served annually over the time frame of the review. The purpose of the study was to define whether such a system could effect timely change in the incidence of tuberculosis (TB) using centralized programme planning and flexible field implementation. A retrospective review of the number of newly diagnosed cases of active TB treated at veterans health care facilities between 1 October 1990 and 30 September 1997 was determined by using a standardized annual case census.

Intervention included implementation of the most current guidelines for the prevention of transmission of TB in the community and hospital setting, including administrative and engineering controls and a change in personal protective equipment. Centrally directed programme guidance, education, and funding were provided for field use in health care facilities of widely varying size and complexity.

The numbers of total reported cases of TB decreased significantly ($P < 0{\cdot}001$) throughout the veterans health care system (nationally and regionally), with the case rate decreasing at a rate significantly greater than that seen in the USA as a whole ($P < 0{\cdot}0001$). TB associated with multi-drug resistance (isoniazid and rifampin) and HIV coinfection also significantly decreased over the study period. Therefore, a large, centrally administered health care system can effectively combat a re-emerging infectious disease and may also demonstrate a successful outcome greater than seen in other, perhaps less organized health care settings.

INTRODUCTION

The re-emergence of TB as a worldwide health problem has been dramatic. In the USA, the number of cases of TB began increasing in the late 1980s. Over the last 15 years, more than 30000 excess cases of TB have been observed compared to that predicted if the incidence of TB had continued to decrease as it had for the prior 20 years [1, 2]. In addition, the emergence of isoniazid (INH) and rifampin resistance (MDR–TB), along with cases of broad-spectrum, multidrug resistant TB [2–10] dramatically changed the outlook for infected patients; with some of these resistant organisms, a clinical cure can no longer be assured. While many of the cases and outbreaks of TB have been associated with HIV co-infection, increased TB

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has also been seen in the non-immunosuppressed population [10].

In response to these issues, several oversight and scholarly groups published recommendations for the prevention of transmission of TB in health care settings, promulgated protocols for treatment of TB in the era of multidrug resistance, and better focused population screening for TB infection [1–3, 8, 9, 11–20]. Most prominent in the area of guidance in the United States has been the Advisory Council for the Elimination of Tuberculosis (ACET) and the US Public Health Services' Centers for Disease Control and Prevention (CDC) with collaboration for non-government entities such as the American Thoracic Society. These groups have issued numerous statements and guidelines in an attempt to stem the re-emerging tide of TB and the spread of MDR–TB in the community. In addition, the US Occupational Safety and Health Administration (OSHA) has issued compliance documents, adding the spectre of enforcement to the guidelines produced by the ACET and the CDC. It should be noted that these documents, taken together, define a TB strategy that includes patients, employees, a variety of health care settings, and many intervention initiatives.

In general, the guidance and enforcement information deals with administrative controls, engineering controls, and personal protective equipment [2]. Embedded in the guidance is information regarding patients in the hospital and the community, health care workers, the environment and the continuum of care. Which of these elements may have the most impact on the prevention of the spread of TB is not clear, but, in the aggregate, they appear effective. However, implementation of these recommendations is complex, expensive and time consuming. As the nation's largest fully integrated health care system, the veterans health care programme administered by the Veterans Health Administration (VHA) of the US Department of Veterans Affairs offers an ideal venue to evaluate the effect of overall implementation of VHA-specific, centrally guided strategies. In addition, the comparison of VHA case rates with overall national rates over the period of review is appropriate as a means of evaluating effectiveness of VHA's initiatives.

METHODS

The VHA annually conducts an Infectious Diseases/Infection Control census utilizing a standardized, automated reporting instrument. From October 1990 to September 1997 (federal fiscal years 1991–7), the VHA's Infectious Diseases/Infection Control census has requested information regarding TB. The instrument is electronically delivered to each VHA facility with active patient care services (VA medical centers and their associated outpatient clinics, nursing homes, domiciliaries, and freestanding clinics) in the continental USA, Alaska, Hawaii, Puerto Rico, and the Philippines. Each facility is required to report data accumulated during the previous Federal Fiscal Year (1 October–30 September). Once completed, the report is forwarded to a central processing site in the VHA Headquarters Infectious Diseases Programme Office. In all cases, data validation and accuracy is the responsibility of the reporting VA medical facility. Discrepant or unusual data reported to the central site lead to verification by telephone.

The following information was requested regarding TB (item 1, for years 1992–7; items 2–4, for years 1991–7):

(1) Total number of newly diagnosed patients with active *Mycobacterium tuberculosis* disease (any site)
(2) The number of newly diagnosed patients with active *Mycobacterium tuberculosis* (any site) who are HIV positive
(3) The total number of newly diagnosed patients with both isoniazid (INH) and rifampin resistant (other drug resistance may or may not be present) active *Mycobacterium tuberculosis* disease (any site)
(4) The number of newly diagnosed patients with both INH and rifampin resistant (other drug resistance may or may not be present) active *Mycobacterium tuberculosis* disease (any site) who are HIV positive

As noted in items 3 and 4, the definition used in this census for reporting MDR–TB is resistance of the isolate to both INH and rifampin, while resistance to other antituberculous agents may or may not be present. Therefore, culture positivity is inherent in this case definition. In the veterans health care system, HIV testing is not mandatory for patients with *Mycobacterium tuberculosis* (MTB) disease. However, testing is strongly encouraged, and there is little disincentive (e.g. patient cost) for HIV testing.

The reported case numbers provided the numerator data for analysis. Denominator data for 1992–6 were defined as the number of unique persons served at the VHA facilities, and was provided by the VHA's

Allocation Resource Center located in Boston, MA. Persons served by the VHA are those actually presenting for an episode of care, not all veterans who may be eligible for care in VA facilities. Comparison data for the USA was used as published by the CDC. Denominator data for 1997 was estimated using a linear regression model and data from the previous 5 years.

Data were analysed both on the national level and by geographically large metropolitan areas (LMA). Six LMAs were assessed. The Southern California area consisted of 3 medical centres; Northern California, 3 medical centres; Chicago, 4 medical centres; New York, 4 medical centres; Coastal Florida, 3 medical centres; and East Texas, 6 medical centres.

All statistical analyses were performed using SAS Version 6.11 [21]. χ^2 tests were used to determine whether the number of TB cases varied across the years. If significant differences were found, χ^2 tests for slope and linearity were further calculated to determine whether the change in TB cases over time was linear, and whether that change was a positive one (increasing number of cases over time) or a negative one (decreasing number of cases over time). A linear regression model was used to compare the rate of change in the rate of TB cases between the VHA-served population and the US population in general.

During the period of the study, VHA Headquarters issued specific, comprehensive TB disease control guidance to the field (20 April 1993) with one major update (11 October 1995) [22, 23], provided national educational programmes and information for practitioners; and funded 152 TB-specific field projects for engineering controls. Each VHA facility received the same guideline documents as issued from VHA Headquarters. All of these efforts used guidance published by the CDC, ACET and OSHA as a basis, but were specifically focused for VHA needs and realities, thus providing specialized support for local facilities. Programmes and interactions occurred throughout the period of review and are designed to be a continuing TB prevention and control effort. In addition, the VHA was an active participant in the National Multidrug Resistant TB Task Force and the National Plan for MDR-TB, both federal initiatives to control TB nationwide.

RESULTS

Figure 1 illustrates the national VHA data for all cases of active *Mycobacterium tuberculosis* disease reported from FY 1992 through FY 1997. The number of cases reported fell 44% over the interval, from 982 in 1992 to 549 in 1997 (χ^2 for linearity, $P < 0{\cdot}001$). Figure 1 also depicts national VHA data for TB disease reported by facilities with the separation of cases known to be related to HIV disease and/or multidrug resistant TB. For this so-called 'traditional' TB, again, the reported case numbers fell 38%, from 781 in 1992 to 483 in 1997 ($P < 0{\cdot}001$, χ^2).

Figure 2a, b shows the national VHA data for patients reported with active TB disease associated with HIV infection or multidrug resistant TB. There were 24 reported MDR–TB cases (Fig. 2a) in FY 1991, dropping to 4 in FY 1997 ($P < 0{\cdot}001$, χ^2). In Figure 2b, TB with co-infection with HIV was reported in 235 patients in 1991, falling to 62 in FY 1997 ($P < 0{\cdot}001$, χ^2). In Figure 2c, the reported cases of MDR–TB with co-infection with HIV were 35 in FY 1991, dropping to 0 in FY 1997 ($P < 0{\cdot}001$, χ^2).

Using the total number of reported TB cases, comparison can be made between total VHA and national US case rates. Figure 3 illustrates the VHA TB rate per 100000 veterans served from FY 1992 through FY 1997. It should be noted that the population of veterans served is different from the US population or veteran population as a whole. Specifically, the denominator represents only those persons served by VHA medical facilities across the country. Also shown in Figure 3 is the TB case rate as reported by the CDC as a rate per 100000 US population. Case rates reported by the CDC have dropped 30% (from 10·5 per 100000 persons in 1992 to 7·4 in 1997). Over the same period, VHA case rates per 100000 persons served have dropped 51% (from 35·8 to 17·7). Since the denominators are different, direct comparison of actual cases would be impractical. Using the linear regression model, we compared the slope of the two decreasing curves; the difference between the VHA and CDC curves is significant ($P < 0{\cdot}0001$) with the VHA demonstrating a more significant decrease in TB case rates. For this calculation, denominators for the number of VHA persons served from fiscal years 1992 through 1997 are the following: FY 1992, $2{\cdot}71 \times 10^6$; FY 1993, $2{\cdot}75 \times 10^6$; FY 1994, $2{\cdot}77 \times 10^6$; FY 1995, $2{\cdot}89 \times 10^6$; FY 1996, $2{\cdot}94 \times 10^6$; FY 1997, $3{\cdot}10 \times 10^6$.

Table 1 shows the number of reported TB cases and

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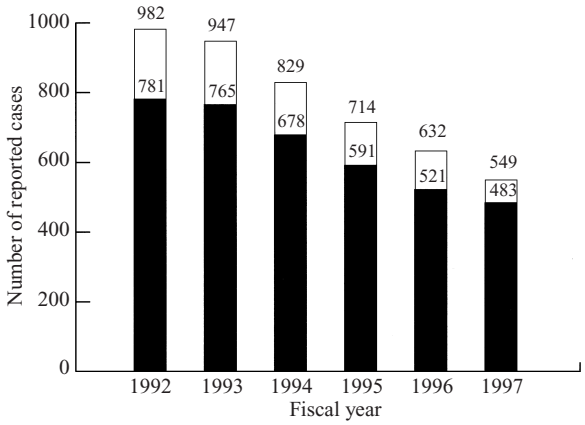

Fig. 1. National VHA data representing all reported cases of *Mycobacterium tuberculosis* are depicted by the entire bar ($P < 0{\cdot}001$, χ^2 for linear trend). National VHA data showing all reported cases of tuberculosis not associated with INH and rifampin resistance and not related to coinfection with HIV is illustrated by the black portion of the bar ($P < 0{\cdot}001$, χ^2 for linear trend).

case rates per 100000 persons served for six LMAs of the country. In Northern California, the Chicago area, the New York area, Coastal Florida and East Texas, both the number of cases and the case rates have declined from FY 1992 through FY 1997 ($P < 0{\cdot}01$ for all areas). The one exception to this outcome is Southern California, consisting of three VA medical centres, where case numbers and case rates have remained unchanged over the 6-year period ($P > 0{\cdot}2$ for both).

Data from FY 1992–7 for reported cases of TB disease in persons co-infected with HIV in these LMAs are reported in Table 2. Case numbers and rates decreased for the New York and coastal Florida metropolitan areas ($P = 0{\cdot}001$ and $P = 0{\cdot}009$, respectively) without concomitant improvement in Southern California, Northern California, Chicago, and Texas. As with total reported cases of TB, there again was a dramatic change in the New York area, which consists of four VHA facilities. Numbers of cases dropped from 69 to 2 (97%), yielding a change in rate from 58·8 per 100000 persons served down to 1·6.

Reported cases and rates of MDR–TB in the six LMAs in 1992–7 were minimal, perhaps because these data represent the cases of MDR–TB in the absence of known co-infection with HIV. However, while 7 cases were reported in the Chicago area in FY 1992, this number dropped to zero in FY 1997. The 5 cases reported from Coastal Florida in FY 1993 decreased to 1 in FY 1997.

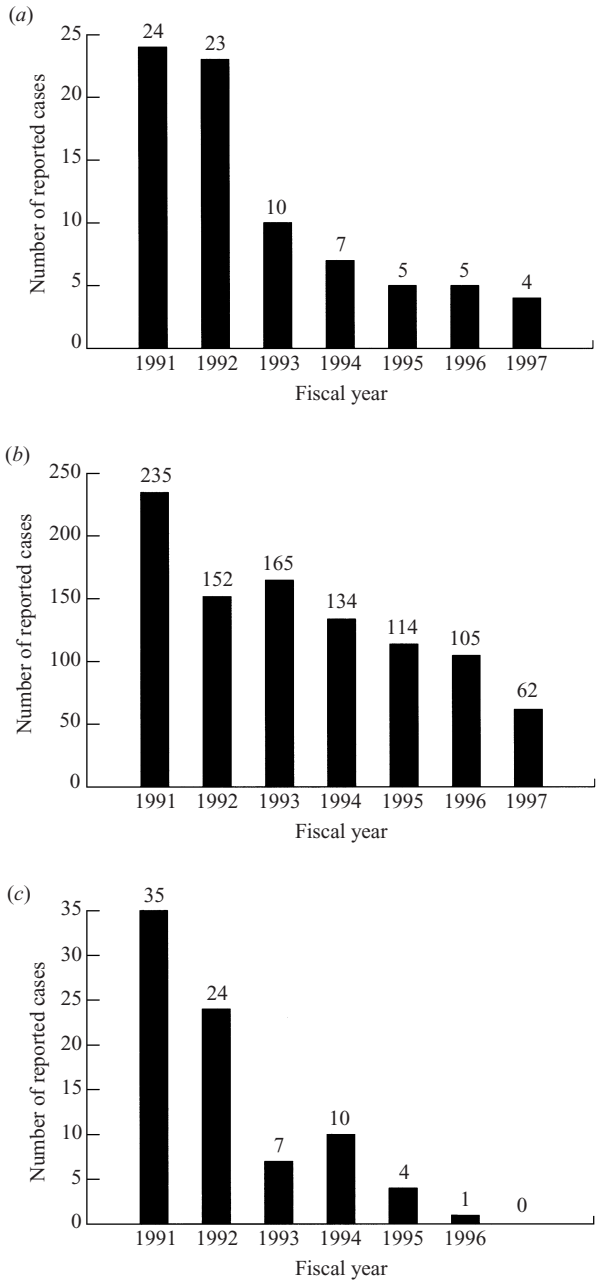

Fig. 2a–c. National VHA data illustrating reported cases of tuberculosis that were either INH and rifampin resistant (a), related to HIV coinfection (b) or both (c). $P < 0{\cdot}001$, χ^2 for linear trend for all three panels.

Table 3 represents persons reported with MDR–TB who are co-infected with HIV in the six LMAs. The majority of cases were seen in the Chicago and New York areas. Of note, however, is the overall decrement in cases, and, therefore, rates, from FY 1992 through 1997 ($P < 0{\cdot}001$), when there were no patients reported with both MDR–TB and HIV co-infection.

With regard to intervention, VA-specific guidance was sent to all VA patient care facilities. One hundred

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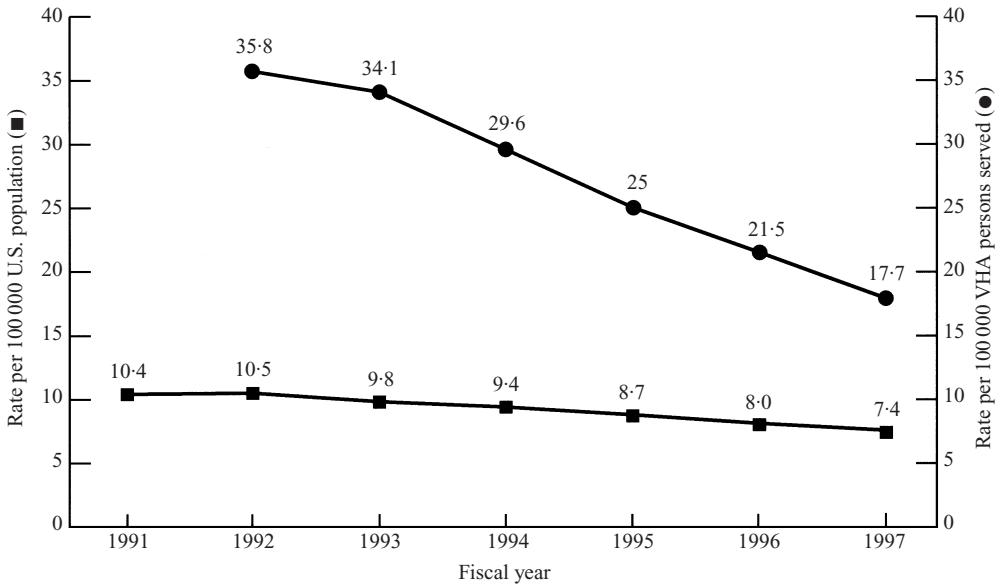

Fig. 3. Rates of reported tuberculosis comparing national CDC data to national VHA data. $P < 0{\cdot}0001$ comparing the slope of the two curves, linear regression model. The national CDC rates are based on number of reported cases in the US population. VHA rates are based on number of reported VHA cases in VHA population served.

Table 1. *TB Cases in the VA 1992–7, Major metropolitan areas*

	1992*	1993	1994	1995	1996	1997
Southern California	50†	49	62	57	61	40
	(47·3)‡	(46·8)	(57·8)	(51·7)	(53·9)	(35·0)
Northern California	23	9	10	17	18	12
	(46·2)	(17·7)	(19·3)	(28·5)	(29·6)	(18·8)
Chicago	51	54	28	56	32	29
	(53·8)	(56·6)	(29·3)	(57·8)	(34·2)	(30·5)
New York	97	72	57	46	30	29
	(82·7)	(61·4)	(49·1)	(39·2)	(23·8)	(23·4)
Coastal Florida	66	56	55	48	31	33
	(46·9)	(39·5)	(37·1)	(34·2)	(23·3)	(24·3)
East Texas	104	104	89	65	65	47
	(76·6)	(77·5)	(65·9)	(46·5)	(44·0)	(31·9)

* Fiscal year.
† Number of cases.
‡ Rate/100000 veterans served.

and fifty-two construction projects were undertaken to provide an appropriate environment of care for TB patients, including changes to improve directional airflow and the number of air changes per hour. National multidisciplinary TB education and training workshops were given three times during the period of the review. At least 600 persons representing 94% of VHA field facilities attended the courses. In addition, 95% of the VHA field facilities represented sent not one person, but a team of persons to the programme. Of those attending, 35% were infection control nurses, practitioners, technicians; 24%, industrial hygienists; 16%, safety specialists, officers, or technicians; 13%, occupational health nurses, practitioners, physician assistants; 8%, physicians, 3%, managers; and 1%, others.

DISCUSSION

Over the last decade, the VHA has made a major concentrated effort to follow the guidance set forth by a variety of expert groups to stem the spread of TB. These various guidelines define a complex paradigm for prevention of transmission of infectious TB in the

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Table 2. *TB Cases with HIV+ coinfection in the VA 1992–7, Major metropolitan areas*

	1992*	1993	1994	1995	1996	1997
Southern California	7†	11	16	17	12	6
	(6·6)‡	(10·5)	(14·9)	(15·4)	(10·6)	(5·2)
Northern California	7	3	1	3	5	1
	(14·1)	(5·9)	(1·9)	(5·0)	(8·2)	(1·6)
Chicago	5	10	4	9	4	3
	(5·3)	(10·5)	(4·2)	(9·3)	(4·3)	(3·2)
New York	46	31	29	19	15	2
	(39·2)	(26·5)	(25)	(16·2)	(11·9)	(1·6)
Coastal Florida	21	20	7	11	10	8
	(14·9)	(14·1)	(4·7)	(7·8)	(7·5)	(5·9)
East Texas	14	24	20	16	12	8
	(10·3)	(17·9)	(14·8)	(11·4)	(8·1)	(5·4)

* Fiscal year.
† Number of cases.
‡ Rate/100000 veterans served.

Table 3. *Multidrug resistant TB with HIV+ coinfection cases in the VA: 1992–7, Major metropolitan areas*

	1992*	1993	1994	1995	1996	1997
Southern California	0†	0	0	0	0	0
	(0)‡	(0)	(0)	(0)	(0)	(0)
Northern California	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
Chicago	3	0	0	0	0	0
	(3·2)	(0)	(0)	(0)	(0)	(0)
New York	18	5	6	3	1	0
	(15·3)	(4·3)	(5·2)	(2·6)	(0·8)	(0)
Coastal Florida	0	2	0	1	0	0
	(0)	(1·4)	(0)	(0·7)	(0)	(0)
East Texas	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)

* Fiscal year.
† Number of cases.
‡ Rate/100000 veterans served.

health care setting and the community at large. To this end, in 1993 [22], the VHA issued specific guidance for the prevention of transmission of TB; this VHA TB guidance was updated in 1995 [23]. The VHA guidance dealt explicitly with the need for triage, rapid diagnosis, appropriate therapy for persons with active TB disease, including directly observed therapy, and the need for specific engineering controls. In addition, the VHA funded 152 construction projects to provide these engineering controls for prevention of spread of TB. In general, these projects improved or created appropriate directional airflow and adequate numbers of air changes per hour in hospital bedrooms and other facilities. Despite controversy, the Department follows the requirements in the area of personal protective equipment set forth by OSHA, as defined by guidance from the CDC [1, 2] and its National Institute of Occupational Safety and Health (NIOSH) branch. These requirements pertain to the use of NIOSH-approved respirators and programmes targeted to meet stringent regulations. Therefore, VHA emphasized prevention of spread of TB in the community by guidance on diagnosis and effective treatment, and in the hospital and clinic settings by adherence to guidance to prevent spread of TB in these higher risk settings.

While it is not possible at this time to define any single component(s) of the plan that was especially related to effectiveness of these programmes and procedures, it can be seen in Figure 1 that the number of cases of active TB reported in the VHA has dropped significantly. This improvement has been

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seen for all types of TB, from the 'traditional' variety to that associated with co-infection with HIV and multidrug resistance. This decrease in case numbers is not a phenomenon based on decreasing workload. Patients served by the VHA increased by 14·4% over the study period, from $2{\cdot}71 \times 10^6$ in 1992 to $3{\cdot}10 \times 10^6$ in 1997.

The decline in TB case rates can be seen in Figure 3. The significantly steeper slope of decrease for the VHA versus the US national data may, in part, be related to the change in demographics in those diagnosed with TB over the last few years. Overwhelmingly, the VHA deals with US citizens over the age of 18. As reported by the CDC, increasing numbers and percent of total cases of TB seen in the USA have been found in the foreign-born [2, 14] and in certain subsets of children [15, 24] not usually represented in the VHA population. However, based on VHA enrollment patterns, the Department seeks and provides care to persons at higher risk for TB, including those with addiction disorders or who are socio-economically deprived, homeless, or in long term care settings [25]. Thus, there is merit in comparing the slope of case rates in the VHA with the slope of CDC-reported national case rates even though the populations served are somewhat different. It should also be noted that the VHA cases are contained within the CDC national data set, since VHA-served persons with TB are reported through the local and state health departments to CDC for tracking purposes. While subtracting the VHA data from CDC's data would have little to no effect because of the size of numbers reported, any observable effect would actually be an increase in the disparity between the VHA and CDC. Of most note, however, assessment of programmatic effectiveness is well served by this comparison. If VHA case rates had not decreased at least at the same rate as the nation as a whole, it would be difficult to claim programme success for the VHA. With data as noted in Figure 3, objective data are available to assess the value of the overall VHA TB initiative.

A review of the LMAs is also useful. As shown in Table 1, decreases in cases and case rates were seen in all the studied LMAs except Southern California. While it is difficult to determine why Southern California did not fall into alignment with the other LMAs, one could speculate that this may be related to transmission of TB from the foreign-born, or difficulties with adequate funding for the general public health infrastructure. However, in the Los Angeles metropolitan area, the CDC reports a decrease in number of cases of TB and in the case rate between 1992 (2325 cases, 25·7 cases/10^5 population) and 1997 (1458 cases, 15·9 cases/10^5 population [26, 27]). Therefore, further epidemiologic review of the VHA cases may be warranted. It is notable that the number of cases and case rates dropped most dramatically in the New York area, consistent with data seen in the non-VHA sector and as reported by the New York Department of Health [28, 29]. Obviously, the VHA decrement in cases and rates in New York is related not only to efforts by the VHA, but also to the massive effort made by New York City and the CDC to bring that epidemic under control. Table 2 reveals data showing TB cases in persons co-infected with HIV decreased in all LMAs, but were only significantly different for New York and Coastal Florida.

The number of persons with MDR–TB in the VHA has been modest from FYs 1992 through 1997, with the exception of a cluster of cases in 1992 in Chicago. For MDR–TB in persons co-infected with HIV (Table 3), the major geographic areas of concern have been Chicago and New York. New York VAs have been remarkably effective in decreasing these TB numbers and rates over the last 6 years, consistent with that seen in the non-VHA sector.

Questions are often raised regarding the ability of a large health care system to respond to change, affect practice and procedure in the field, and measure the outcome of corporate decision making, especially in today's healthcare cost containment environment. With the resurgence of TB and the spread of MDR–TB, particularly in the HIV co-infected population, the VHA made the decision to effect change through central guidance, funding, and policy decision, while encouraging local flexibility regarding specific strategies for implementing these initiatives. With the help of field representatives, VHA Headquarters defined specific guidance for the control of TB. This guidance, covering all aspects of TB control was executed with intense clinical activity in the field. Centrally funded construction projects also were prioritized by the clinical need at each facility for TB containment. Though controversial, the VHA decided that respiratory protection in alignment with CDC guidance and OSHA regulations would be used throughout the system, and broad-based implementation was undertaken. While not directly related to prevention of diseases in patients, appropriate controls for employees are designed to decrease spread of infection and disease in this group who is at risk for

TB disease and adverse outcomes [1, 2, 30, 31]. In addition, major efforts were made to create a collegial relationship between VHA facilities and local health departments for reporting and tracking purposes, as well as, in some cases, outpatient follow-up with directly observed therapy of VHA patients.

In conclusion, these data suggest that a large organized healthcare system can very effectively adapt to new problems such as the resurgence of TB; put forth a nationwide, unified effort for control of an emerging disease; and document effectiveness of an intervention programme across the nation. The relative greater effectiveness of this effort compared to the nation as a whole suggests that VHA's efforts might serve as a prototype for the increasing numbers of large health care systems in the USA.

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